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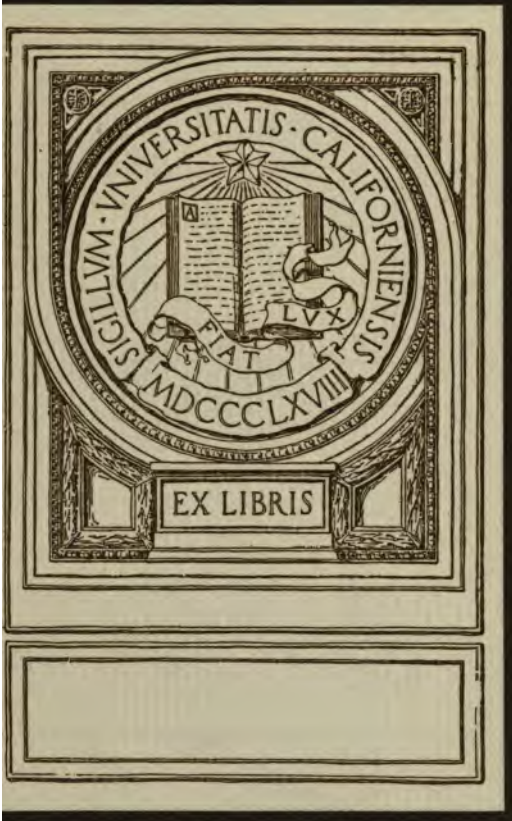
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# GEOLOGICAL SURVEY.

UNIVERSITY OF CALIFORNIA

## BULLETIN NO. 2.

1.—*The State of Mining in the Kimberley District;*

2.—*The Probability of obtaining Artesian Water between the Pilbarra Goldfields and the Great Desert;*

BY

Ex
JAN 28 1929

R. NEIL SMITH, M.A., F.G.S.,
*MINING ENGINEER.*

*Issued under the Authority of the Hon. H. B. Lefroy, M.L.A., Minister for Mines.*

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# PREFACE.

IN December, 1897, owing to there being no officer of the Geological Staff available, Mr. R. Neil Smith, M.A., F.G.S., Mining Engineer, of Kalgoorlie, was specially employed to report upon the state of Mining in Kimberley district.

On his way back from the North Mr. Smith was deputed to visit the neighbourhood of Warrawagine Station, to inquire into the possibility of obtaining a supply of artesian water between the Pilbarra Goldfields and the Great Desert. The reports, on being submitted to the Hon. The Minister for Mines, were ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 12th July, 1898.

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# CONTENTS.


| | PAGE |
|---|---|
| Preface ... ... ... ... ... ... ... | iii. |
| Contents ... ... ... ... ... ... ... | v. |
| Index ... ... ... ... ... ... ... | v. |
| The State of Mining in the Kimberley District ... ... ... | 7–23 |
| Hall's Creek ... ... ... ... ... ... | 8 |
| Brockman's ... ... ... ... ... ... | 10 |
| Ruby Creek ... ... ... ... ... ... | 14 |
| Mary River ... ... ... ... ... ... | 16 |
| Mount Dockrell ... ... ... ... ... ... | 17 |
| Panton River ... ... ... ... ... ... | 18 |
| General Summary ... ... ... ... ... | 19 |
| Crushing Returns ... ... ... ... ... | 19 |
| The Probability of obtaining Artesian Water between the Pilbarra Goldfields and the Great Desert ... ... ... ... | 24 |


## LIST OF PLATES.


PLATE 1.—Sketch Plan of Mines at Hall's Creek, Mount Bradley Tunnelling Claim.

„ 2.—Ruby Queen Gold Mine.

„ 3.—St. Lawrence Gold Mine.

„ 4.—Geological Sketch Map of Kimberley Goldfield.

„ 5.—Geological Sketch Map of the Oakover and Nullagine Rivers.

# 1.—The State of Mining in the Kimberley District.

The Kimberley District embraces all that portion of Western Australia forming the watersheds of the Fitzroy and Ord Rivers, and the country between them. Two roads have been opened and telegraph lines laid down, one South from Wyndham to Hall's Creek, and one East from Derby to Hall's Creek. These roads are of a distance of 250 and 350 miles respectively. Proceeding from Wyndham the road traverses river valleys between prominent flat-topped carboniferous (Woodward) ranges for a distance of about 100 miles. These ranges are succeeded by highly contorted Devonian (Hardman) country, which continues in two approximately parallel belts in a South-Westerly direction to the fringe of the Great Desert South of Mount Dockrell.

Between these two strips of Devonian country the road continues along granite and gneissic country until a distance of about 200 miles from the coast is reached.

At this point highly inclined shales and sandstones, in places considerably metamorphosed, make their appearance and continue without interruption except by occasional diorite or basaltic dykes as far as Mount Dockrell. This is the auriferous belt of the Kimberley Goldfield. It consists of stratified rocks evidently older than the Devonian, but its exact geological age is indeterminate, no fossils having been found in any part of it.

In many respects it considerably resembles the Lower Silurian deposits of the western part of Victoria, and the Upper Silurian of several parts of New South Wales. The sandstone is more micaceous, and the shales on the whole exhibit less of a true slatey cleavage than is seen on the Victorian fields. This has been already pointed out, I believe, by Mr. Hardman in his report published in 1885. The various portions of this auriferous belt, on

which work has been done, succeed one another in a South-South-Westerly direction, and are as follows, beginning from the farthest North:—

The Panton River and Dry Creek.
Hall's Creek.
Brockman's.
Ruby Creek.
The Mary River.
Mount Dockrell.

The extreme distance from the Panton River to Mount Dockrell is about 120 miles, the Panton River itself being about 210 miles from Wyndham. I shall give a description of these various localities, and conclude my report with a general description of the resources of the field, based on the observations made at the different centres.

## HALL'S CREEK.

The general appearance of the country here is that of a series of prominent ridges running in a North to North-Easterly direction. Some of these ridges are "razor-backed," having a conspicuous "backbone" standing vertically some 10ft. to 20ft. above the sloping sides of the ranges. On inspection this "backbone" is found to consist of a dyke of felsite, conforming in strike and dip with the surrounding stratified country rock.

The country, as a whole, consists of micaceous sandstones and shales highly inclined, with a North-North-Easterly strike and generally underlying to the East. These shales and sandstones form conspicuous outcrops on the side of the ranges, and, owing to the unequal weathering of the different layers of minerals, present a highly laminated appearance. The sandstones are generally highly micaceous, the mica being arranged in layers parallel to the strike of the rock. They vary in colour from yellow to dark green. The shales are of a green or blue colour, and also exhibit mica in the laminations. Some of the shales exhibit a slatey cleavage parallel to the direction of the strike, and probably due to an East and West pressure. Others pass gradually into mica schists.

In some sections the shale or slate is seen in narrow bands 1in. to 3in. wide, and 2ft. to 5ft. apart, the intervening rocks being micaceous sandstones. In other sections the shales are seen to attain a thickness of many feet. The strike of the mountain ranges, the strike of the sandstones and shales, the direction of the schistose layers of mica, and the trend of the great felsite dykes, all

point to the fact that the main fissuring of the country will be in a like direction, that is to say North-North-Easterly. Gneiss, exposed in the bed of the Bow River some 100 miles North, exhibits the same direction in the arrangement of its minerals.

Diorite dykes occur in places generally conforming in direction with the strike of the country, but in a few instances running across from East to West.

Basalt dykes occur on the road from Wyndham, and a great sheet of basalt, the "Great Antrim Plateau," lies some 30 miles to the East, and on the Eastern side of the Ord River.

Mining, other than by a few alluvial fossickers, has completely stopped at Hall's Creek.

The "Jubilee" (*vide* Plate 1, Fig. 1) shaft has been sunk, with the aid of the Government bonus for deep sinking, to a depth of 30ft. below the 100ft. level, but a portion of the workings is now inaccessible. Where it is possible to descend it is seen that the reef varies from 18in. to 2in. in width, and has an East and West strike across the country rock, which here consists of indurated dark blue schists with a North-North-Easterly strike. The reef consists of quartz stained with oxide of iron, and containing a considerable quantity of galena. It has been stoped out from a drive 30ft. long from the 40ft. to the 20ft. level. This portion of the stone yielded, according to the published returns, 490ozs. of gold from 23 tons of stone. The Government bonus for deep sinking was utilised to sink the main shaft from 100ft. to 130ft., but as no further work has been done, and the mine is now abandoned, the presumption is that no stone below this 40ft. level was payable. Out of the above-mentioned crushing returns 362ozs. were obtained from $5\frac{1}{4}$ tons of stone. This reef is undoubtedly a segregation vein, one which cannot be depended upon to continue for any considerable distance either in depth or in the direction of the strike. An assay of stone taken from the 40ft. level gave a result of—tellurium *nil*; gold, 4dwts. 7grs.; silver, 1oz. 15dwts. per ton.

The "Lady Broome" (*vide* Plate 1, Fig. 1) is another abandoned mine at Hall's Creek. The reef, as far as could be seen, is 3in. to 9in. wide, and, like the "Jubilee" reef, runs across the country with an East and West strike. It has been exploited by two shafts 90ft. apart and 70ft. deep. No mineral could be seen in the quartz lying on the surface. An assay of this stone gave a result of—gold, trace; silver, 2ozs. 5dwts. 4grs. per ton; tellurium, *nil*. The country rock consists of a bluish shale. The only crushing return was previous to 1897, and amounted to 30ozs. from 400 tons of stone.

The "Lady Broome North" has also been abandoned for years. The stone lying on the surface contains a small amount of galena and oxide of iron. A little calcite is also present. These three mines, the "Jubilee," the "Lady Broome," and the "Lady Broome North" are all situated on the side of a hill, at the foot of which a gully runs from which a considerable amount of alluvial gold has been taken.

To the North of Hall's Creek, and some 1½ miles distant from these mines, lie the "Jackson's Reef" and the "Jackson's Reef South."

"Jackson's Reef" (*vide* Plate 1, Fig. 1), originally held by a company, has been abandoned for many years, and the shaft is now inaccessible. It could be seen, however, that the reef consisted of a small quartz vein and a few stringers of quartz laminated with the schists, which are here very hard. The reef is a segregation vein, and, therefore, of but short duration. The crushing returns from this vein were 56ozs. 18dwts. from 78 tons of stone.

"Jackson's South" contains a vein somewhat resembling that in "Jackson's Reef," but smaller. It will be seen from the sketch that all these mines are situated on a strip of country some half-mile wide and close to one of the prominent felsite-backed hills.

With regard to Hall's Creek generally, it may be said that there is no indication of any true fissure reef. The reefs which have been worked consist of segregation veins running either with or across the strike of the country rock. These veins, where found to be payably auriferous, have been only 9in. to 12in. thick. The quartz, as a whole, contains a large proportion of galena, and, in places, smaller quantities of iron pyrites, copper pyrites, malachite, and hematite.

The great felsite dykes forming the crown of the more conspicuous hills contain innumerable quartz veins running in every direction, but no gold has been found in these.

There is no battery at Hall's Creek. Fuel is plentiful on the field, and there is a fair amount of timber suitable for heavy work. Lighter timber for underground work is plentiful. Underground water is plentiful, being struck at a depth of from 50ft. to 200ft.

## BROCKMAN'S.

The workings at "Brockman's" lie some eight miles from Hall's Creek in a South-Westerly direction.

The general contour of the country is somewhat similar to that at Hall's Creek, the rocks of the district also bearing a close

resemblance to those at the former place, consisting of alternate beds of metamorphosed sandstones and shales. The sandstones are micaceous like those of Hall's Creek, but both the sandstones and shales are in most places of a lighter colour, indicating that they contain a much smaller proportion of decomposed hornblende. These strata are highly inverted, and strike in a North-North-Easterly direction.

The alluvial gold was much richer and more widely distributed than on any other portion of the Kimberley Goldfield. Most of the gold-bearing quartz reefs have been discovered by tracing up their connection with the neighbouring alluvial. The only mine being worked at present is the "Mount Bradley Tunnelling Claim." (*Vide* Plate 1, Fig. 2.) Many others have been worked, but abandoned years ago. There are three men employed on the "Mount Bradley." There are also a few alluvial fossickers in the district.

"Mount Bradley."—This mine is situated on a conspicuous hill rising some 200ft. above the surrounding country. The auriferous quartz reef forms the crest of the hill, and outcrops to a height of 5ft. to 10ft.

This quartz reef has the characteristics of a true fissure vein. It has a regular strike parallel to that of the surrounding sedimentary shales and sandstones. The dip is also regular and parallel to that of the country rock, being about 3 in 100 to the West. There is a well-marked hanging wall, striated in places, and with a rolling contour. The country rock on this wall is much broken and decomposed, forming a flucan, or "dig." The movement has evidently taken place in the plane of this wall. The reef is from 10ft. to 15ft. wide, and is composed, for the most part, of white quartz, poorly mineralised. There is a vein of a much better appearance between this large vein and the country on the hanging wall. This vein is only from a few inches to half an inch wide; and, towards the north end of the workings, disappears altogether. The tunnel, which is at present being used for working the mine, penetrates the western side of the hill, and is some 300ft. in length. It passes through a yellowish micaceous sandstone, interbedded with narrow bands of yellowish shale. This sandstone forms the western or hanging wall of the reef, the footwall consisting of a yellowish, greasy shale, penetrated by a mass of leaders running from the main reef.

This tunnel intersects a shaft (No. 1) (*vide* Plate 1, Fig. 3) at a depth of 115ft. from the outcrop. This shaft is continued to a depth of 96ft. below the level of the tunnel. It was impossible to

get down the shaft more than 40ft. below the tunnel level owing to a stage and tram rails being laid over it. I was shown some of the quartz from the bottom level, which was coated with a lustrous black graphitic shale. One piece of quartz from the bottom of this shaft contained a very large proportion of iron pyrites. An assay of this gave a result of—tellurium, *nil*; gold, trace; silver, 3dwts. 6grs. per ton.

From the tunnel level there are two drives North and South of 60ft. and 40ft. respectively. A good deal of stoping has been done between these drives and the outcrop of the reef. The main reef outcrops in several places, the first being some 400ft. North of No. 1 shaft. Another reef, outcropping near this, should junction with the main reef somewhere in the locality of the tunnel.

About 100ft. South of the main shaft a shaft (No. 2) (*vide* Plate 1. Fig. 3) has been sunk on the floor wall of the reef to a depth of 123ft. The reef has been stoped out from a drive at the bottom of this shaft to the outcrop for a length of about 30ft., and a width of about 2ft. I was informed that this was good stone. Work has been discontinued here, but it is the intention of the management to connect these workings with the south drive from the main shaft. Some 60ft. South of No. 2 shaft the hill slopes down sharply to the level of the surrounding valley.

A third shaft (No. 3) has been sunk on a small reef 18in. wide. This vein should be close to the hanging wall of the main reef.

The published crushing returns from the "Mount Bradley" are —1,971 tons for 1,579ozs. of gold previous to 1897, and 70 tons for 34ozs. in the first half of 1897.

From the tunnel level in the main shaft to the bottom the shaft has been sunk by the aid of the Government bonus for deep sinking. This depth is 96ft., or a total depth of 211ft. from the surface.

This mine is well provided with crushing appliances. A 10-head battery, worked by a portable engine, is erected, and has been in use for some years. The boxes are somewhat worn, but if the plates and blanket tables were kept in order, and either Berdan pans or amalgamating barrels provided, good results should be obtained. Even with the present appliances assays of the tailings gave results of only 8dwts. 4grs. and 2dwts. 10grs. of gold per ton.

A Wheeler's pan has been used for supplementing the battery amalgamation. On retorting the amalgam from this pan a black mass, containing 95 per cent. of metallic iron, resulted. This must be derived from chips of metallic iron from the shoes and dies, or from excessive grinding in the Wheeler's pan. A battery of 15 heads lies unerected on the ground. A good supply of water has been struck, which, according to the manager, would keep 10 heads working for 16 hours in the 24.

"Golden Crown."—This is another mine in which the Government bonus was utilised to sink below the 100ft. level. The mine is situated about 2½ miles North of the "Mount Bradley." Like all other mines at Brockman's, with the exception of "Mount Bradley," it is now abandoned, the machinery having been removed to the latter mine. Portion of the workings being inaccessible, I had to depend upon the former owner for much of my information. The auriferous vein runs in a North and South direction, and has an average width of about 2ft. The country rock, consisting of the usual shales and sandstones, strikes North-North-East. The walls of the reef consist of a decomposed sandstone penetrated in every direction by a network of leaders running from the reef. Higher up the hill on which this reef outcrops, and some 20ft. to the West, is seen a prominent mass of white barren quartz, evidently forming portion of a main reef which is seen cropping out on a neighbouring hill. The general strike of this main reef is North-North-East parallel to the shales and sandstones. The probability is that there is a main fissure running with the country. In this there are several large quartz veins developed, mostly barren, one of which, however, of a comparatively small width, has been proved auriferous. This, the "Golden Crown" reef, touches the walls of the fissure on neither side. This could be proved by putting in an East and West cross-cut from the bottom of the main shaft. The quartz is of a bluish colour, and contains a small amount of galena and iron pyrites. On either side of the main shaft the reef has been stoped out for a length of 60ft., and for a depth of 70ft. At the 100ft. level a drive 23ft. long has been put in to the South. I was informed that the reef is here 30in. wide, and the stone worth 26dwt. per ton. At the 100ft. level a large quantity of water was struck, and work was discontinued. Twenty-nine feet of the shaft was sunk by Government aid. The published crushing returns are —1,148 tons for 1,389ozs. previous to 1897, and 5½ tons for 6½ozs. in the first half of 1897.

"Faugh a Ballagh."—This mine is situated about a mile North of the "Golden Crown." It has been abandoned for some time. The

reef consists of a small quartz vein running North-West and South-East across the strike of the country which here, as in other parts of the field, is North-North-East, and consists of highly inclined sandstones and shales. The quartz is white or iron stained. No mineral could be found in the quartz obtained except a little galena and dendritic markings of manganese. The stone was examined for tellurium, but no trace was present. The reef is without doubt a segregation vein. The Government bonus was utilised to sink the shaft from the 100ft. level for a depth of 25ft. The published crushing returns are 6 tons for 6ozs. previous to 1897, and 9 tons for 11ozs. in the first half of 1897.

The "Lady Margaret" mine consists of some workings on a cross leader which intersects a dyke of hornblendic rock, probably a diorite. This dyke has the same strike and underlay as the surrounding sandstones and schists, which are here highly indurated. The leader has a strike of West-North-West, and a steep dip to the South, and varies in width from 6in. to 2ft.; but at this greater width the stone is poor. The stone has been stoped out on either side of the dyke for a length of about 40ft., and a depth of from 25ft. to 55ft. The stone gives out, going East, and the gold going West. Small veins of calcite can be seen on either wall of the leader. The dyke is some 10ft. wide, and on its West side a quartz reef runs North and South in contact with the dyke on the East, and the shales and schists on its West. On the East side of the dyke the country consists of an indurated micaceous sandstone. The crushing returns were—97 tons for 252ozs. previous to 1897. No work has been done on this mine for some years.

## RUBY CREEK.

This field is situated some 12 miles beyond Brockman's. The same character of rocks appear here as at Hall's Creek and Brockman's, but there is a much larger proportion of sandstone to the clay rock or shale. This shale appears often as a true slate in bands from 1in. to 4in. in thickness, and 2ft. to 3ft. apart, the interstratified rock being a yellow to brown micaceous sandstone. These slates and sandstones strike in a North-North-Easterly direction, and have a highly inclined dip to the East or West. A conspicuous felsite dyke, similar in appearance to that at Hall's Creek, rises prominently as the crown of a well marked succession of ranges trending in a North-North-Easterly direction. The main break in the country caused by this line of felsite dykes seems to be closely connected with the fracturing of the country rock, and the deposition of the gold, as in four of the centres at least it is found in close

proximity to the auriferous veins. The two most important mines at Ruby Creek, and the only two which have not been abandoned, are the "Ruby Queen" and the "St. Laurence."

The outcrop of the "Ruby Queen" line of reef can be traced as the noticeable crest of a North and South range of hills for a distance of three miles. This extensive reef has been worked in the following mines from South to North:—"Ruby Queen," "Ruby Queen No. 1, No. 2, No. 3, No. 4 (West and Left), No. 5, No. 6, No. 7." The best stone was obtained in the "Ruby Queen No. 4 and No. 7." The reef throughout would average about 3ft. in width. The workings in the West and Left are on a cross reef, the junction of which with the main reef has not yet been exploited. Nearly all the work done on Ruby Creek has been confined to the "Ruby Queen" line of reef, the "St. Lawrence" being the only mine of importance off the line.

All the mines mentioned above have been abandoned with the exception of the "Ruby Queen." More work has been done on this mine than on any other on the Kimberley Goldfield, and it has been well opened up. It has been worked mainly by two tunnels (*vide* Plate 2, Figures 1 and 2) running North and South along the reef from a precipitous gully. The outcrop of the reef rises to a height of from 130ft. to 200ft. above this level. The North tunnel is 305ft. long, the South tunnel 155ft. The main shaft, on which is erected a whim, intersects the South tunnel 47ft. from the surface. From the tunnel level the shaft has been sunk 204ft., making a total depth of 247ft. From the 100ft. level to the bottom of the shaft the sinking was accomplished with the help of the Government bonus, 64ft. being sunk in 1895 and 87ft. in 1896. The reef varies in width from 12in. to 8ft., the average being about 3ft. The quartz is of a dark blue colour where richest, and contains vughs full of an impure hematite. Most of the good stone is next the walls, but sometimes the gold is found disseminated throughout the reef. There is not much mineral in the stone, except in places a little iron pyrites. The gold is fine. The reef has well marked walls, especially the eastern one. There seems little doubt that this is a fissure reef. The walls are well defined, rolling, and striated. A "flucan," or "dig," is found between the reef and the country rock. The country rock consists of a micaceous sandstone, with thin layers, 1in. to 2in., of bluish slate. The East wall of the reef consists of sandstone, the West of slate or shale. The stoping done in this mine is extensive, as can be seen from the accompanying sketch. The crushings from these stopes varied in value from 12dwts. to 17dwts. The underlay is steep, and as will be seen from the accompanying sketch, varies from East to

West, in each case conforming with the dip of the slates and sandstones. At the bottom of the shaft a cross-cut has been put in to the West, and at a distance of 25ft. cut the reef, which was here broken up into a number of small veins, separated by bands of graphitic shale containing crystals of iron pyrites.

The largest battery on the field is in connection with this mine. but is, unfortunately, at a distance of about a mile from the workings. It consists of 20 heads, in four boxes, made by Langlands of Melbourne. The boxes are in a fairly good condition. There are two engines on the ground, the larger one being of sufficient power to drive the 20 heads. The battery is provided with amalgamated copper plates and blanket tables. The screens used have 240 and 280 holes to the square inch. The crushing returns, were—6,000 tons for 4,500ozs. previous to 1897, and 67 tons for 31½ozs. in the first half of 1897. There are now more than 100 tons ready to be crushed.

The " St. Lawrence " has been worked until recently. The reef has a remarkably irregular strike somewhat in the shape of an inverted S. The shales forming the casing of the reef seem to conform with this strike, but how far this extends into the general mass of the country rock it is impossible to say without a long and careful examination. Sandstones having the usual North-North-Easterly strike outcrop as shown on accompanying sketch. The reef has an average width of about 3ft. The quartz contains but little mineral, and is of a dark blue colour. It has not been stoped to a greater depth than 70ft., but the average results have been very good. The stone is richer where the reef is smaller, especially in the smaller horse-shoe shown on the sketch. From the bottom of the main shaft, 105ft. deep, an East cross-cut was put in to cut the reverse leg of the reef. It was found broken into a number of small veins, and poor. The stone to the North of the tunnel is also poor, and has not been worked. From the crushing returns it will be seen that the result is the best ever obtained on the Kimberley Goldfield from a large body of stone, 1,275 tons yielding 1,498ozs. previous to 1897, and 102 tons 91ozs. in the first half of 1897.

## MARY RIVER.

This locality, which lies 16 miles South-West of Ruby Creek, is quite deserted. But little work has been done here. One shaft has been sunk on a narrow vein of calcite, interbedded with micaceous hornblendic schist. The whole has a North-North-Easterly strike, and is highly inclined. The shaft was sunk to some depth on the underlay, but the stone was only payable near the surface.

On the "Reform" mine a trench has been opened for a length of 60ft., and a depth of 20ft., showing a reef 2ft. to 3ft. wide. The quartz is very poorly mineralised; small veins of calcite run in the direction of the reef. The shaft is filled with dirt and water to within 30ft. of the surface. The published crushing returns were —399 tons for 229ozs. previous to 1897. There is a good 5-head battery on the Mary River, about half a mile distant from the "Reform" mine. The battery is in good preservation, and has been driven by a double-cylinder portable engine. A Wheeler's pan is also on the ground.

## MOUNT DOCKRELL.

Mount Dockrell is the most outlying portion of the Kimberley Goldfield, being close to the edge of the Great Desert, and some 50 miles from the Mary River in a Southerly direction. Quartz mining on this field has been abandoned for years, but a few alluvial fossickers visit it at intervals. The geological formation is much the same as on other parts of the field, consisting of highly inclined beds of sandstones alternating with beds of shale passing into slate and mica schist; the whole striking North-North-East. There is a large proportion of mica in the sandstones and slates, and the quartz also contains mica in places. Very little work has been done on this field, and it has revealed only small veins of quartz interbedded with the country, in some places carrying gold, but only to a shallow depth.

In one claim, "McNeill's," some very good stone was obtained, 40 tons yielding 352ozs. This was all obtained within about 15ft. of the surface. The shaft was continued to a depth of 50ft. or 60ft., but nothing below this level was payable. This shaft has been filled up by dry-blowers. The stone at the lower depth contained a large quantity of galena, which gave an assay result of 9ozs. of silver per ton, and a trace of gold; no tellurium could be found.

The adjacent mine, the "Victoria," obtained a portion of this shoot of gold a few feet from their boundary with "McNeill's." Their return was 123ozs. of gold from four tons of stone. A vertical shaft, 25ft. to the East, was sunk with the intention of cutting the reef, but after penetrating a dyke of diorite containing a very large proportion of hornblende, work was discontinued at a depth of 25ft. Several cross trenches have revealed this reef at a distance of a few chains North and South. The stone is white and unmineralised, and no work has been done at these trenches other than exposing the reef. The reef throughout, as far as could be seen, would average about 12in. in width.

Near these mines a light 5-head battery is lying unerected. A good portable engine and a stone-breaker are also on the ground.

The supply of timber is poor, and surface water is also unreliable. Water has not been struck at a depth, the workings all being shallow.

The "Black Prince" is another abandoned mine in this district, and the shaft is now filled up within 15ft. of the surface. As far as could be seen the shaft was sunk on a series of small parallel veins interbedded with decomposed slates or shales.

## PANTON RIVER.

This portion of the Kimberley Goldfield is situated at the extreme North end of the known auriferous country. It is some 42 miles in a North-North-Easterly direction from Hall's Creek. A fair amount of work has been done here, but all the mines, with the exception of two, the "Star of Kimberley" and the "Nil Desperandum," are now abandoned. Most of the country consists of a plain covered in places with a considerable depth of black alluvium. One of the high felsite-backed ridges appears some miles to the West, and some low hills are seen to the North-East. A slight rise of about 10ft. above the plain exhibits the outcrop of a quartz reef which can be traced for about a mile. This outcrop conforms in strike with the country rock, which here consists of the usual sandstones and shales. A cluster of mines, the "Comet," "Caledonian," "Lone Hand," etc., lie near the low hills to the North-East. The "Lone Hand" has just been abandoned, and the shaft is now full of water. The others have been abandoned for years, and the workings have fallen in. There is no battery on the Panton River, a good 5-head battery having been removed to the Mary River.

The "Star of Kimberley" after having been abandoned for years was again taken up while I was on the field, and I obtained a sample of stone broken by the first shot put in after the resumption of work. This stone contained a large proportion of galena. An assay gave a result of—tellurium, *nil*; gold, 3dwts.; silver, 12dwts. The workings consist of three shafts, two of which are 30ft., and one—the only one now being worked—70ft. deep. The reef is 3ft. to 4ft. wide, and has been left standing for 20ft. in the shaft. The only published crushing return from this mine is one ton for 16dwts. I had not enough opportunity of determining whether this is a fissure reef, but there seems a probability of its being so. The "Nil Desperandum," another mine now being worked, consists of a shaft 30ft. deep on a quartz leader 1in. to 3in. thick, running into a main line of reef on which the "Star of Kimberley" is situated. This shaft is only 15ft. from this main line. Some rich stone was obtained from this leader, but the shoot was only about 5ft. long, and seems to be related to a vertical fault which causes a slight displacement of the leader and the surrounding country. This stone was examined for tellurium, but no trace was present.

The "Lone Hand," situated some two miles North-East from these mines, has just been abandoned. The reef consists of a quartz vein about 14in. thick, interbedded with the country. A shaft has been sunk for a depth of 60ft. From the surface to a depth of 16ft. some 260oz. of gold were obtained, but in the next 44ft. of the shaft not even a trace could be obtained. At this lower level the reef consists almost wholly of galena, which, on examination was, found to contain—tellurium, *nil*; gold, *nil*; silver, 26ozs. 12dwts. per ton. The country rock is a greenish schist, much decomposed, and not highly laminated. The shoot of gold is wedge-shaped, the greatest width being 15ft.

## GENERAL SUMMARY.

It will be gathered from the foregoing description of the various mining centres on the Kimberley Goldfield that very little work has been done, except on a few mines, since the visit of the Government Geologist in 1891.

The following table shows the total recorded crushings since the discovery of the field:—

## CRUSHING RETURNS.

| Mines. | Previous to 1891. | | 1891 to 1897. | | First half 1897. | |
|---|---|---|---|---|---|---|
| | Tonnage. | oz. dwt. grs. | Tonnage. | oz. dwt. grs. | Tonnage. | oz. dwt. grs. |
| Mount Bradley ... ... | 789 | 810 9 15 | 1,182 | 768 8 15 | 70 | 33 16 0 |
| Golden Crown ... ... | 1,000 | 1,250 0 0 | 148 | 139 10 4 | 5½ | 6 11 0 |
| Ruby Queen ... ... | 2,000 | 1,500 0 0 | 4,000 | 3,000 0 0 | 67 | 31 10 0 |
| St. Laurence ... ... | 233 | 277 10 0 | 1,042 | 1,220 9 12 | 102 | 91 0 0 |
| Brockman King ... .. | ... | ... | 24 | 17 17 8 | 61 | 21 7 0 |
| Right Bower ... ... | ... | ... | ... | ... | 5 | 3 0 0 |
| Rose ... ... ... | ... | ... | ... | ... | 64 | 30 18 0 |
| Faugh-a-Ballagh ... | 6 | 6 5 0 | ... | ... | 9 | 11 4 0 |
| Lone Hand ... ... | ... | ... | ... | 260 0 0 | | |
| Jubilee ... ... ... | 9½ | 408 13 12 | 13½ | 87 0 0 | | |
| Comet ... ... ... | 1½ | 134 0 0 | 26½ | 13 6 20 | | |
| Afghan Crown ... .. | 64 | 48 8 0 | 30 | 26 2 0 | | |
| Union ... ... ... | 30 | 45 10 0 | 57 | 62 9 0 | | |
| West and Left ... ... | 189 | 376 18 0 | 490 | 657 1 0 | | |
| Rising Sun... ... ... | 500 | 437 0 0 | 77 | 98 6 0 | | |
| Sunny Corner ... ... | 20 | 60 0 0 | 2 | 4 11 12 | | |
| Reform ... ... .. | 3½ | 11 0 0 | 396 | 217 17 0 | | |
| Star of Kimberley ... | 1 | 0 16 0 | | | | |
| Perseverance ... ... | 5 | 3 0 0 | | | | |
| Lady Broome ... ... | 400 | 30 0 0 | | | | |
| Do. No. 1 N. ... | 6 | 4 3 0 | | | | |
| Gladstone ... ... ... | 2 | 3 17 0 | | | | |
| Jackson's Reef ... ... | 78 | 56 18 0 | | | | |
| Black Mount ... ... | 8½ | 3 8 0 | | | | |
| Lady Margaret ... ... | 97 | 251 14 19 | | | | |
| Do. No. 1 N. | 20 | 16 6 12 | | | | |
| Do. No. 5 N. | 6½ | 9 6 0 | | | | |
| Southern Cross ... ... | 5 | 3 5 0 | | | | |
| McNeill's ... ... ... | 40 | 351 14 0 | | | | |
| Victoria ... ... ... | 4 | 123 6 0 | | | | |
| Total ... ... | 5,519 | 6,218 8 10 | 7,487 | 6,572 19 9 | 383½ | 299 6 0 |
| Average value ... | ... | 1 2 12 | ... | 0 17 12 | ... | 0 12 0 |
| Number of Mines crushing ... ... | ... | 26 | ... | 14 | ... | 8 |

Present number of mines working, five.

The cause of this stoppage of all but a few mines is almost invariably due to the stone at a comparatively shallow depth becoming too poor to work. Water for domestic and mining purposes is plentiful. Fuel and mining timber are fairly abundant, and, although the cost of carriage of goods from the coast is heavy, still living is no more expensive than on many portions of the Southern fields which are now being worked. Wages are £4 per week.

The abandoned mines, with one or two exceptions, are in a most dilapidated state. The wood-work of the shafts has decayed and fallen in in many cases, and in others the shafts are full of dirt and water. Comparatively few mines could therefore be carefully inspected.

The country, as has been mentioned above, resembles somewhat the older Silurian country, in which many of the Western goldfields of Victoria are situated. It is impossible, however, to deduce from this resemblance that the Kimberley gold reefs will resemble that of Victoria; for in Victoria itself much of the country in which the reefs are perfectly barren resembles in every detail the country in which the rich auriferous reefs occur.

A portion of the Pilbarra Fields, which I passed over very rapidly, resembles the Kimberley country; but there is a wide difference between the Kimberley Field and the Southern Fields of this Colony. The difference is nowhere greater than between Kimberley and the Kalgoorlie Field, where telluride of gold is being profitably mined in this Colony.

In the latter field the lode material itself consists of a schistose hornblendic rock, probably metamorphised dyke material. There is no parallel to this in the Kimberley Fields.

In considering the value of auriferous quartz reefs two points must be carefully studied:—

1. The continuance in length and depth of the quartz reef.
2. The continuance in length and depth of the shoot of gold.

The quartz reefs of Kimberley can, for my purpose, be classed under two heads:—

1. Fissure veins.
2. Segregation veins.

The ordinary characteristics of fissure veins have been described above. Segregation veins continue for a comparatively short distance and depth; they may run with the country or across it, but in either case are highly unreliable, and in no case could be regarded as forming a mine. The known auriferous veins of the

Kimberley Field belong, with one or two exceptions, to this class. These exceptions, which are fissure reefs, have been named above. Such reefs can be relied upon to continue sometimes for miles in length, and for thousands of feet in depth.

Many of the segregation veins of the Kimberley Goldfield, as can be gathered from the preceding description, have yielded small patches of highly payable stone. These patches, however, have almost invariably given out at a very shallow depth, as may be observed from studying the table of crushings given above. This can also be observed from the nature of the workings on the mines, character of the stone, etc.

There has been fairly good alluvial gold obtained in parts of the Kimberley Field, and this, although necessarily derived from quartz reefs, does not therefore predicate that these reefs are payable, for three reasons :—

1. The quartz reef from which this alluvial gold is derived may be too small to be payable.
2. Nearly all, or all, of the gold-bearing portion of the reef may have been denuded, and only the barren portion left.
3. The gold may have become concentrated in the alluvial leads in which it has been found.

So we find that in Kalgoorlie some of the best alluvial gold was obtained on the Western slopes of the hills from " Hannan's Reward" and " Maritana Hill." This was almost certainly derived from small quartz veins dipping into these hills.

Little need be said with regard to the best system of ore treatment to be adopted on the Kimberley Goldfield. In considering this three points must be observed :—

1. Nature of gold.
2. Nature of lode stuff.
3. Accompanying minerals in lode stuff.
    1. The gold is generally of an average size, but in a few cases is moderately fine.
    2. The lode stuff is quartz.
    3. The accompanying minerals are small quantities of iron and arsenical pyrites, oxides, carbonates and sulphides of copper, and, in several cases, a large quantity of galena.

The lode stuff could not be more suitable for ordinary battery treatment. The fineness of the gold in places, and the large quantities of galena in others, need consideration.

To save such fine gold, fine battery screens, well-kept copper plates and blanket tables, the blanketings being treated in Berdan pans or amalgamating barrels, is all that is necessary. If the galena occurred commonly with the rich stone its presence would occasion some difficulty; but it is a peculiar fact that the galena, as a rule, is only present in large quantities in a reef after the rich stone has given out. This galena, as has been stated above, contains a little silver, and generally a trace of gold.

In the exceptional case where a large quantity of galena occurs in rich stone, the stone should either be sent away for treatment to some smelting works, or, if it be not rich enough to warrant this, a frequent cleaning of the plates, and the use of sodium amalgam to prevent sickening of the mercury, is all that can be done. A certain loss of gold will result, but this cannot well be obviated on a small scale.

The retorted gold will, of course, contain a large quantity of lead, but this can be easily removed by sending the retorted gold to smelting works, or to the mint.

Samples of stone were taken from all parts of the field, but no trace of tellurium could be found. As has been stated above, the geological character of this country is very different to that of Kalgoorlie, where there is such a valuable deposit of tellurides of gold, and the field is no less different to the other portions of the world where tellurides of gold are found in payable quantities, such as Mount Morgan, where it occurs in a contact lode between Permo-Carboniferous shales and dolerite; Cripple Creek, Colorado, where the lodes occur in phonolite, andesite breccia, and in granite, and other parts of America where it occurs in gneiss. The fact that tellurides of gold are very rare minerals, only found in payable quantities in three or four parts of the world, combined with the fact that in the nearest of these, Kalgoorlie, the lode occurrence is of an entirely different character, would point to the conclusion that there is little probability of tellurides of gold being found in payable quantities on the Kimberley Goldfield.*

Traces of tellurium are said to have been found recently in one of the Victorian goldfields, and so traces may be found at some time in the Kimberley field, but there is no indication to that effect.

The Government bonus for deep sinking below the 100ft. level has been used in the case of seven mines. Three of these mines were of fair promise. In such cases the use of the bonus might have demonstrated the existence in depth of payable stone. If the stone had been payable it would have led to increased sinking, not

*That is over the small portion which has already been explored. A.G.M.

only in these mines, but in many other parts of the field. Unfortunately the stone became poorer in depth.

In the case of the other four mines there is no doubt that the bonus was misapplied, the reefs being of small width and uncertain continuance both in length and depth. The only use of the bonus in such cases is to enable miners to earn good wages. A Government bonus for sinking should *only be granted in order to demonstrate something not already known,* in this case the continuance or non-continuance in depth of payable stone on the Kimberley Goldfield.

In the three cases mentioned above it seems a wise thing to have granted it, but now that so many of the mines of the field have become poorer in depth, the aid, if given at all, should only be given after careful recommendation by a trained mining engineer,* as is done in some of the Eastern Colonies. In any case there seems to be no reason why the bonus should be given on this field more than on many portions of the Southern goldfields.

The past history of this field will, I think, be the future history of the field. Patches of alluvial gold, and small veins of uncertain continuance, will be found at rare intervals, which will pay working shareholders well for a few months.

The finding of main fissure reefs, containing payable stone, is much more unlikely. The prominent outcrop of such a reef on the bare Kimberley hills would have led to its discovery years ago. This probable future of the field, combined with its past history, point to but one conclusion, *i.e.*, that the field is not suitable for large companies, but for the gaining of a precarious living by working miners.

R. NEIL SMITH,
Mining Engineer.

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* Or other scientifically trained officer. A.G.M.

## 2.—The Probability of obtaining Artesian Water between the Pilbarra Goldfields and the Great Desert.

From Roebourne to Condon, a distance of 210 miles, the country consists of flat plains of sand, clay, and beds of shingle, with a few local intrusions of hornblendic rock, probably diorites.

From Condon to the De Grey station, and along the De Grey River to a distance of about 100 miles from the coast, the country consists of a like series of plains with a gradual rise of between 100ft. and 200ft. Some 90 miles from the coast there is a North and South range of porphyry, and close to the East side of this an outcrop of granite extending in a few low hills to a distance of about 10 miles North of the river. At a distance of 100 miles from the coast a prominent range is cut through by the river. This range consists of two parallel ridges about half-a-mile apart, and rises to heights varying from 100ft. to 400ft. above the level of the river.

Owing to a storm of wind and rain which compelled me to push on for shelter some 40 miles further East, the exact nature of the rocks forming this range could not be determined. It consisted of a series of hills stretching in a North and South direction for about 10 miles North of the river, and then turning East and West as shown on accompanying sketch map. These hills were flat-topped and broken by frequent abrupt gorges. The crest of the range consisted of a horizontal stratum of a highly indurated rock; the lower strata being so much softer as to have become weathered away, leaving a succession of small caves some 10ft. to 20ft. from the summit of the range. This range crosses the river and proceeds in the direction of Bamboo Creek.

The two parallel ridges forming this range, and the valley between them, occupy a strip of country about a mile wide. They rise abruptly from the plains, and form at this point the Western boundary of Warrawagine Station.

Some five miles East of this range gneiss and granite begin to outcrop, and continue to the junction of the Nullagine River with the Oakover. The Eastern branch of the range mentioned above

can be seen in the distance as a series of isolated flat-topped hills stretching Eastwards to the edge of the Great Desert.

From the junction of the rivers onward to the Warrawagine Homestead, and for five miles beyond, a total distance of 20 miles, the country is flat and covered with beds of clay, sand, and gravel, and in a few places with "cement."

Five miles South of the homestead a low irregular series of limestone hills make their appearance. These hills are all of small extent, and are dotted in all directions over the strip of country between the Nullagine and Oakover Rivers. The summit of nearly every hill is, to the eye, perfectly horizontal, due to horizontal beds of silica, which have protected the underlying beds of limestone from denudation. The flats between these hills consist of limestone, with here and there small stretches of bean-shaped ironstone pebbles. This belt of limestone country is bounded on the East by the Oakover River, crossing it only for a very limited area 10 miles South of Braeside Station. High cliffs of crystalline limestone appear on the West bank of this river at Carawine Pool and Tooncoonarlagee, about 100 miles South of the junction of the Nullagine and Oakover.

From the base of these cliffs springs of water, highly charged with lime, issue and flow into the Oakover. At Tooncoonarlagee the supply must be many thousands of gallons per day. Similar cliffs are seen on the Little River, and on the "Nullagine Gorge," where a large mass of ironstone breccia also appears. According to the geological map published by the Department of Mines in 1894, this limestone extends South and West for hundreds of miles.

Some four miles East of the Oakover River, and running approximately parallel with it, a prominent range rises abruptly from the surrounding alluvial plains. This consists, where inspected, of an amygdaloidal melaphyre, the exact nature of which it was impossible to determine owing to the decomposition of the exposed rock. This range is from 200ft. to 400ft. above the bed of the river, and extends for a distance of many miles, skirting the greater portion of the Eastern boundary of Warrawagine.

Five miles West of the Nullagine River there is a series of low granite and gneissic rises extending to within 10 miles of Bamboo Creek. This, probably, is a continuation of the granite outcrop appearing on the North side of the De Grey River.

Some seven miles East of Bamboo Creek some beds of indurated sandstone make their appearance. They have a dip of about 20° to the East, and rise about 80ft. above the surrounding country. At

Bamboo Creek itself a great dyke of felspar and quartz porphyry occurs.

I was not able to see the country South of Bamboo Creek and West of Warrawagine, but it consists, I believe, of low granite hills and rises, except where the auriferous belt of Bamboo Creek penetrates it.

Many wells have been sunk along the banks of the De Grey River and on Warrawagine and Braeside Stations. In most cases a plentiful supply of fresh water was obtained at a depth of from 20ft. to 40ft. In one place, five miles East of the junction of the Oakover and Nullagine, on the edge of the desert, salt water was struck after passing through a layer of "cement" consisting of a decomposed dolomite.

At Braeside a well sunk to a depth of 32ft. furnished a plentiful supply of water after penetrating the following strata:—

| | ft. | in. | |
|---|---|---|---|
| Red Clay ... ... ... | 30 | 0 | |
| Cement ... ... ... | 0 | 6 | |
| Loose Gravel ... ... | 0 | 6 | (carrying water.) |
| Pipe Clay ... ... ... | 1 | 0 | |
| | 32ft. | | |

At Warrawagine a well was sunk, and, after penetrating about 40ft. of clay, water was obtained in a bed of gravel overlying cement.

In order to obtain an artesian water supply in any locality the following conditions must be present; the absence of any one of them preventing a supply:—

1. An upper layer of impervious material.
2. A layer of freely porous material.
3. An under layer of impervious material.
4. The continuity of these three layers on to some high ground.

The nature of this high ground must be as follows:—

(*a.*) The upper impervious layer must continue to such a height as to give a head of water sufficient to overcome the resistance of penetrating the porous layer and of rising in the bore to the surface in sufficient quantity.

(*b.*) The porous layer must rise to an equal or greater height.

(c.) The lower impervious layer must be higher than this again, and must be of sufficient superficial extent to give a constant supply of water at the locality of the bore. This extent is of course dependent on the rainfall.

My examination of the district was very hurried, but it enabled me to form an opinion with regard to the absence of the above conditions.

1. An upper layer of impervious material covers the country wherever inspected, except over a few patches of granite.

2. A porous layer is doubtless present in most places, but is generally only a few inches in thickness, and consists of loose beds of gravel. These beds are probably not continuous for a great distance.

3. Granite doubtless underlies all the country, but in many places must be at a comparatively shallow depth.

4. The upper impervious layers continue on to the higher ground of the plains, but do not rise up the slopes of the ranges. The porous layer is not exposed at the foot of the ranges, nor does it rise on the slopes. As mentioned above, it is probably a series of unconnected beds of small extent. In the case of granite risers, or even of the melaphyre range on the East, the impervious bottom layer was carried on to a height of from 250ft. to 400ft. above the surrounding country. These ranges were, however, of an inconsiderable breadth, and had, therefore, a comparatively small watershed. The annual rainfall in the district is 15in., although 38in. to 42in. have fallen during the late phenomenal season.

A large proportion of this rain-water must penetrate the limestone, as is evidenced by the springs occurring at the base of the cliffs.

The comparatively small superficial extent of the impervious ranges, and the probable want of continuity of the water bearing stratum to this higher ground, are both unfavourable to the probability of obtaining artesian water in this district.

R. NEIL SMITH,
Mining Engineer.

By Authority: A. CURTIS, Acting Government Printer, Perth.

Hon. H.B. Lefroy M.L.A.
Minister for Mines.

# SKETCH PLAN

SHOWING THE POSITION OF THE MINES AT
HALL'S CREEK, KIMBERLEY GOLDFIELDS

Scale
(Approx.) ½ mile = 1 inch.

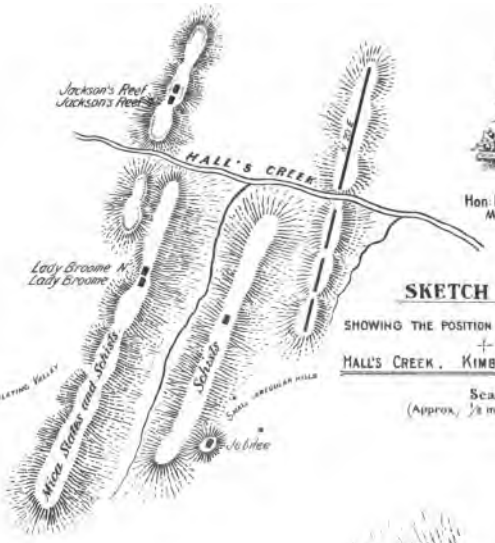


FIG 1.

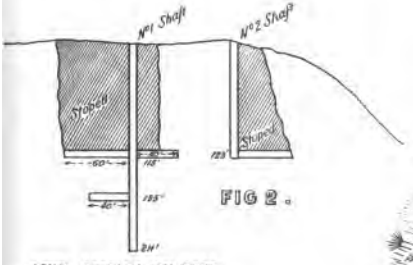


FIG 2.

LONG: SECTION ON REEF

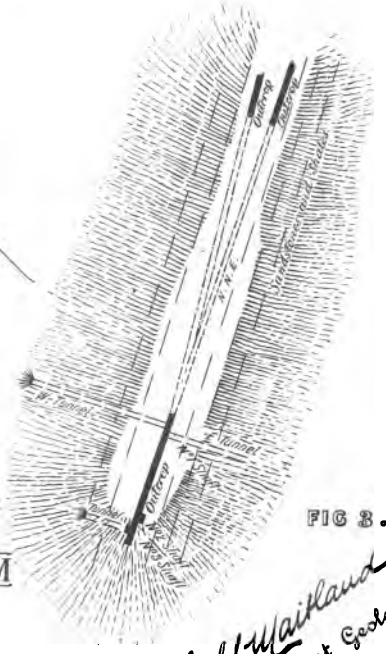


FIG 3.

PLAN

# Mc BRADLEY TUNNELLING CLAIM

— Scale —
(Approx) 100 ft = 1 Inch

Alfred Maitland
Government Geologist

Photo-lithod. 29/7/08

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# RUBY QUEEN GOLD MINE

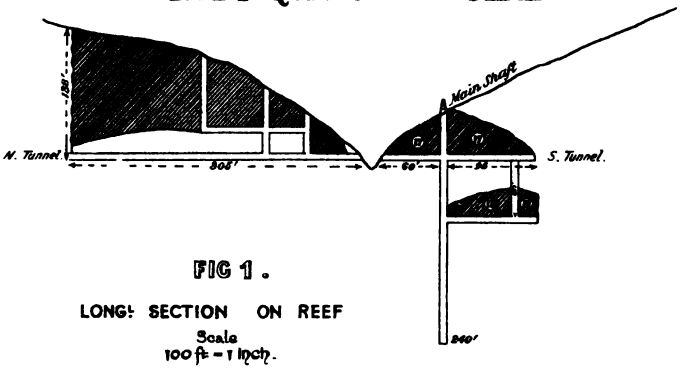
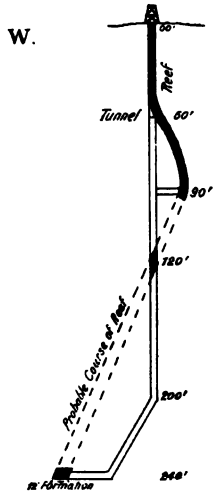



FIG 1.

LONG! SECTION ON REEF

Scale
100 ft = 1 Inch.



Hon: H.B. Lefroy M.L.A.
Minister for Mines.

FIG 2.

TRANSVERSE SECTION THROUGH MAIN SHAFT
RUBY QUEEN G.M.Co.

Scale
50 ft = 1 Inch

Alfred Maitland
Government Geologist

Photo-lith 4th 29/11/02

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# Stᵗ LAURENCE GOLD MINE

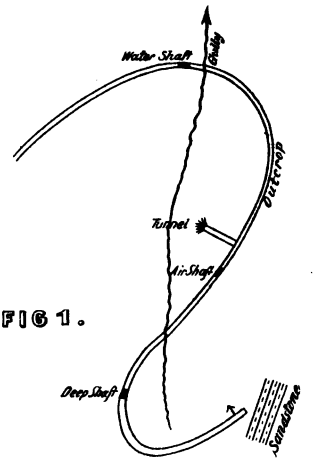


FIG 1.

— PLAN

Hon: H.B.Lefroy M.L.A.
Minister for Mines.

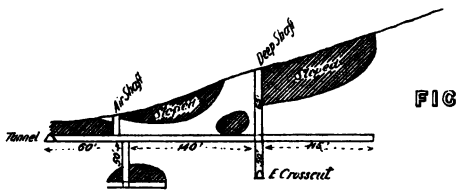


FIG 2.

LONGI SECTION ON REEF

Scale
100 ft = 1 Inch

Alfred Maitland
Government Geologist

Reduced as at 1/4/08

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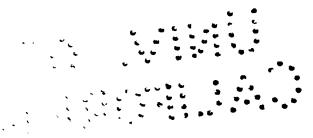
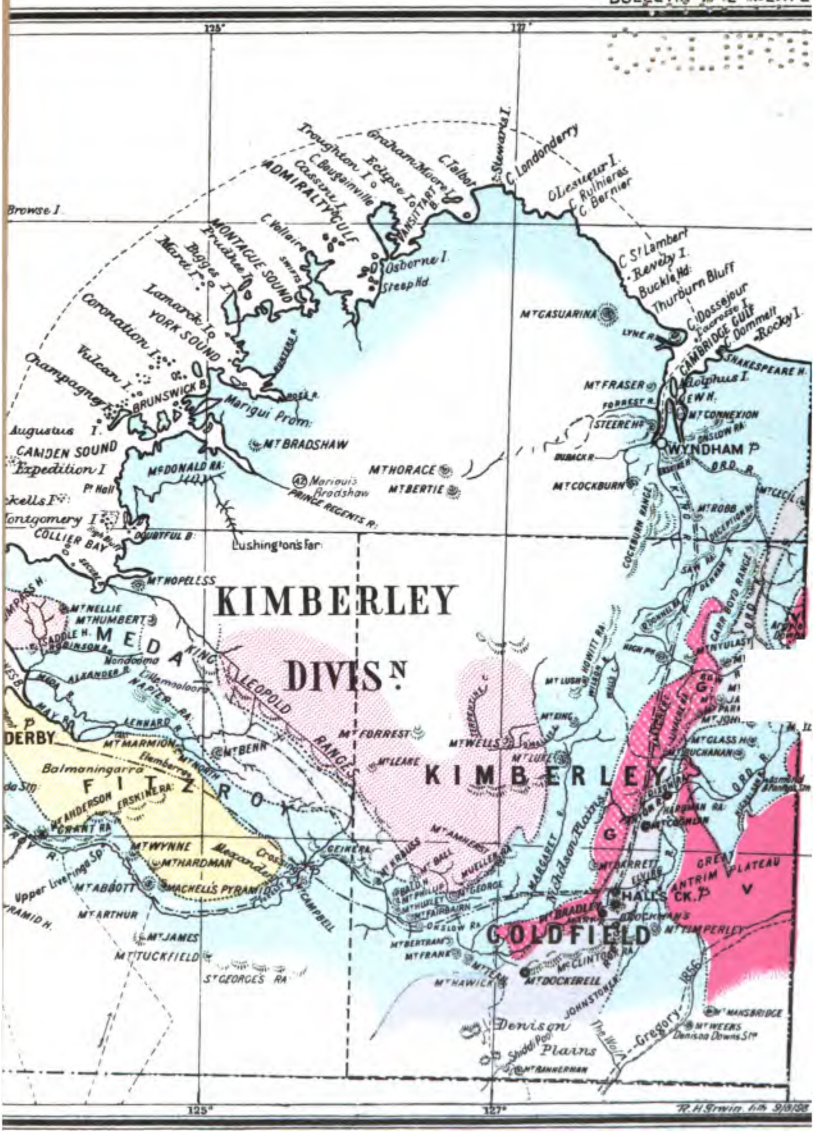


BULLETIN No 2 PLATE



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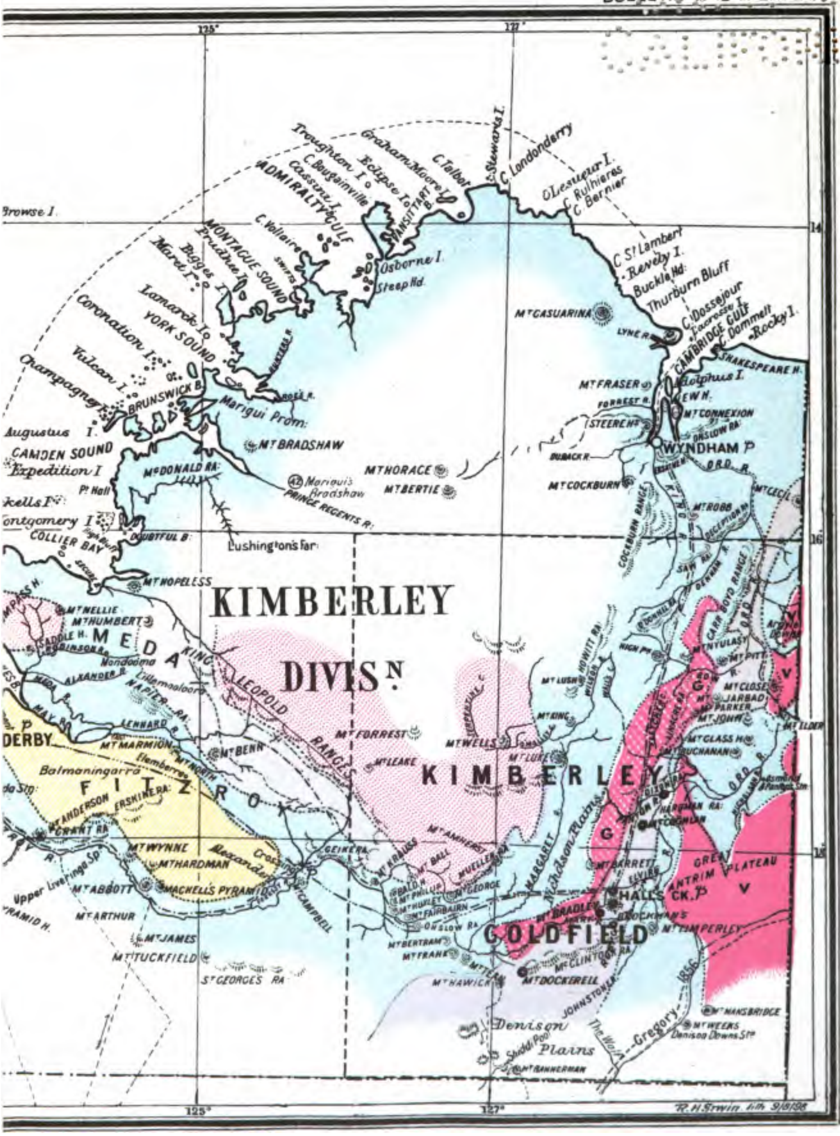
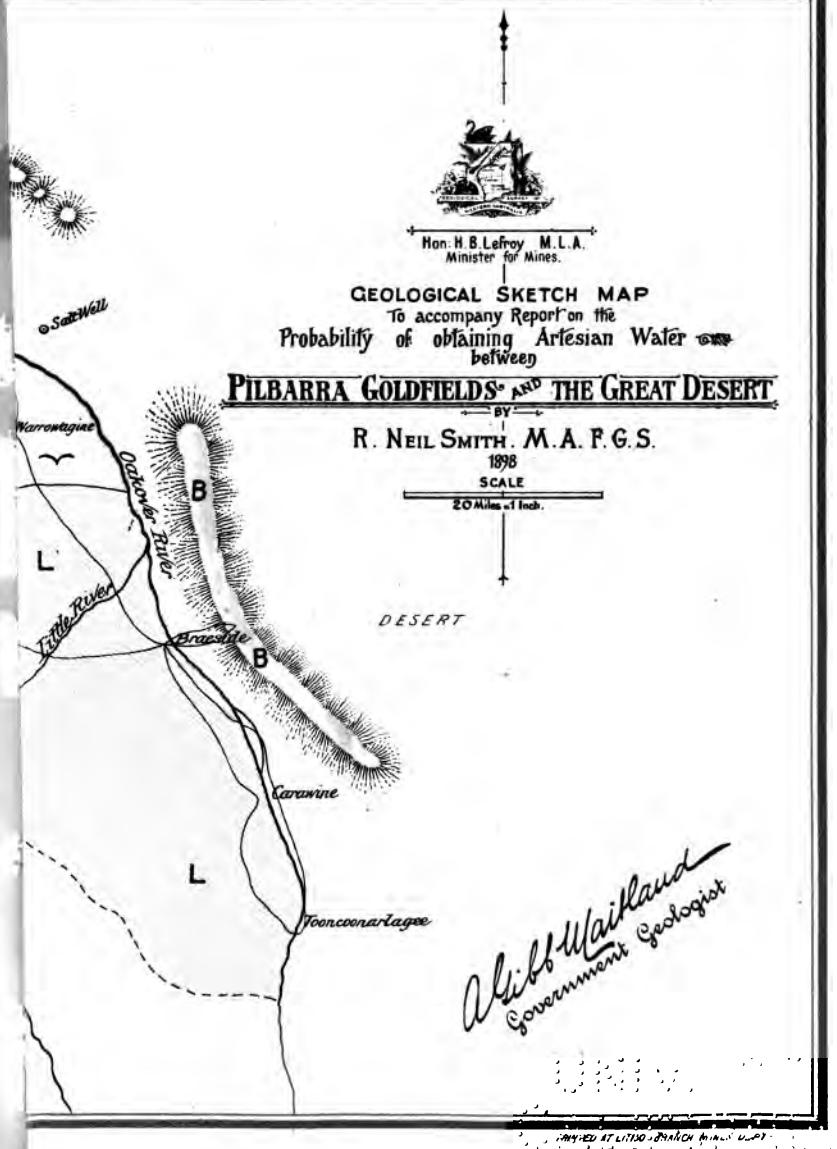

125°
127°
14
16
18
Browse I.
Troughton I.
Graham Moore I.
Eclipse I.
C. Bougainville
Cassini I.
ADMIRALTY GULF
C. Talbot
VANSITTART B.
Stewart's I.
C. Londonderry
Lesueur I.
C. Rulhieres
C. Bernier
C. Voltaire
MONTAGUE SOUND
Prudhoe I.
Bigges I.
Maret I.
Osborne I.
Steep Hd.
Lamarck I.
YORK SOUND
Coronation I.
Vulcan I.
Champagny I.
BRUNSWICK B.
Augustus I.
CAMDEN SOUND
Expedition I
Pt. Hall
Montgomery I.
COLLIER BAY
DOUBTFUL B.
Marigui Prom.
MT BRADSHAW
MCDONALD RA.
Lushington's Far.
MT HORACE
MT BERTIE
PRINCE REGENTS R.
MT CASUARINA
C. St Lambert
Reveley I.
Buckle Hd.
Thurburn Bluff
C. Dossejour
CAMBRIDGE GULF
C. Dommett
Rocky I.
LYNE R.
SHAKESPEARE H.
MT FRASER
Adolphus I.
FORREST R.
MT CORNEXION
STEERE H.
WYNDHAM
ORD R.
MT COCKBURN
COCKBURN RANGE
MT ROBB
DECEPTION R.
MT CECIL
CARR BOYD RANGE
MT HOPELESS
KIMBERLEY
DIVISN.
MEDA
KING LEOPOLD RANGES
MT NELLIE
MT HUMBERT
SADDLE H.
ROBINSON R.
Mondooma
ALEXANDER R.
NAPIER
LENNARD R.
MAY R.
DERBY
MT MARMION
Elemberrea
MT NORTH
Balmaningarra
FITZROY
ERSKINE RA.
MT ANDERSON
GRANT RA.
MT WYNNE
MT HARDMAN
Alexander
MACHELLS PYRAMID
Upper Liveringa Sp.
MT ABBOTT
MT ARTHUR
PYRAMID H.
MT JAMES
MT TUCKFIELD
ST GEORGES RA.
MT BENN
MT FORREST
MT LEAKE
MT WELLS
MT LUKE
KIMBERLEY
MT LUSH
MT KING
HOWITT RA.
MT TULASY
MT PITT
MT CLOSE
JARBAD
PARKER
MT JOHN
MT CLASS H.
BUCHANAN
MT ELDER
GEIKIE RA.
MT AMHERST
MT BALL
MUELLER RA.
MT GEORGE
MT FAIRBAIRN
ONSLOW RA.
MT BERTRAM
MT FRANK
MT HAWICK
MT DOCKERELL
MT CLINTON
COLDFIELD
HALLS CK.
GREAT ANTRIM PLATEAU
HARDMAN RA.
MT BRADLEY
BROCKMANS
MT TIMPERLEY
MT COGHLAN
MT BARRETT
ELVIRE
MARGARET
Nicholson Plains
Denison Plains
JOHNSTONE
The Wells
Gregory
1856
MT WEEKS
Denison Downs Stn.
MT BANNERMAN
MANSBRIDGE
Shiddi Pool
R. H. Irwin, lith. 9/8/98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Minister for Mines.
GEOLOGICAL SKETCH MAP
To accompany Report on the
Probability of obtaining Artesian Water
between
PILBARRA GOLDFIELDS AND THE GREAT DESERT
BY
R. NEIL SMITH. M.A. F.G.S.
1898
SCALE
20 Miles = 1 Inch.
Salt Well
Warrowagine
Oakover River
Little River
Braeside
Carawine
Toonconarlagee
DESERT
B
B
L
L
Alfred Gaitland
Government Geologist

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